Lidar Remote Sensing of Vertical Foliage Profile (VFP) and Leaf Area Index (LAI)

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Introduction

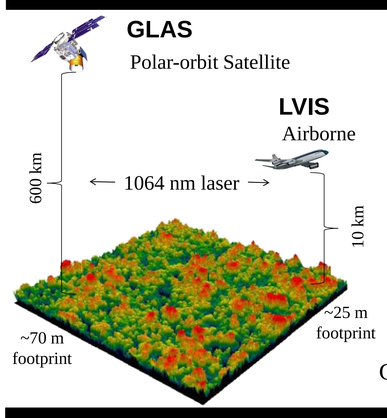
Forest structure parameters, such as LAI and VFP can provide potentially important information that can be used not only to better quantify biomass and its changes, and to refine input variables of ecosystem models and help improve carbon flux estimates.

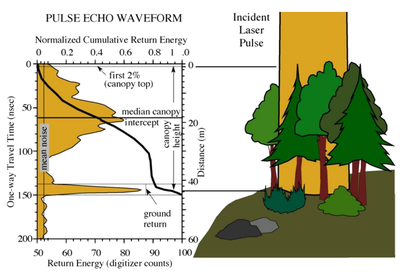
The overall goal of this study is to derive and validate continental scale LAI and VFP products using full waveform lidar data acquired by the Geoscience laser Altimeter System (GLAS) onboard ICESat (Ice, Cloud, and land Elevation Satellite).

In order to achieve this goal the following objectives will be met:

1. ***Develop and test a physically-based model to derive LAI and VFP from airborne waveform lidar data.***
2. ***Develop a robust Lidar-LAI model and validation framework for deriving LAI and VFP from spaceborne lidar.***
3. ***Derive and validate Lidar-derived LAI and VFP products at different scales across major forest types.***

Lidar Data





Full-Waveform Lidar
Laser Vegetation Imaging Sensor (LVIS)
Geoscience Laser Altimeter System (GLAS)

Field LAI Measurement

Destructive Sampling

Hemispherical Photo

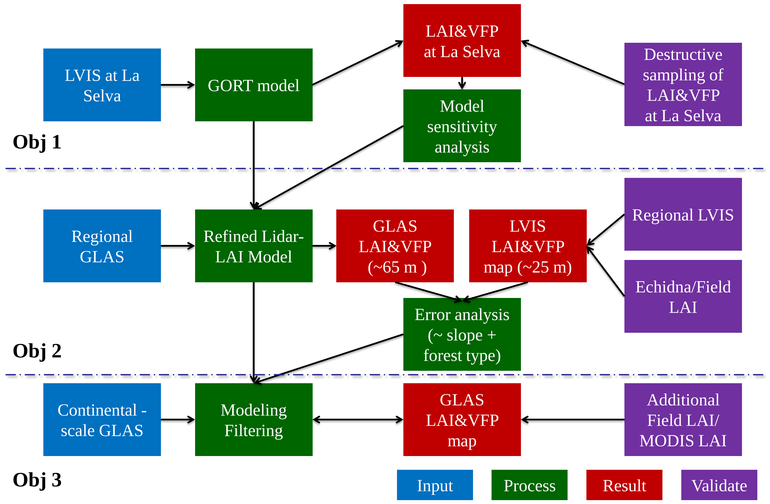
LAI-2000

Echidna®

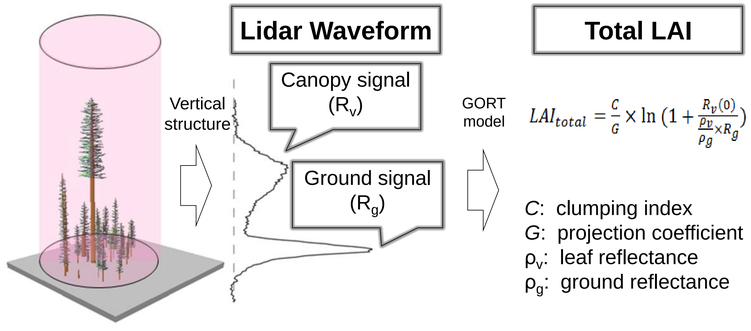
Table 1 Data Acquisition Time

Site location	*LVIS Acquisition*	*Field Acquisition*
La Selva, Costa Rica	2005	2003-2005
Sierra Forest, CA	2003, 2008	2008
Howland Forest, ME	2003, 2009	2007
Harvard Forest, NH	2003, 2009	2007
Bartlett Forest, NH	2003, 2009	2007

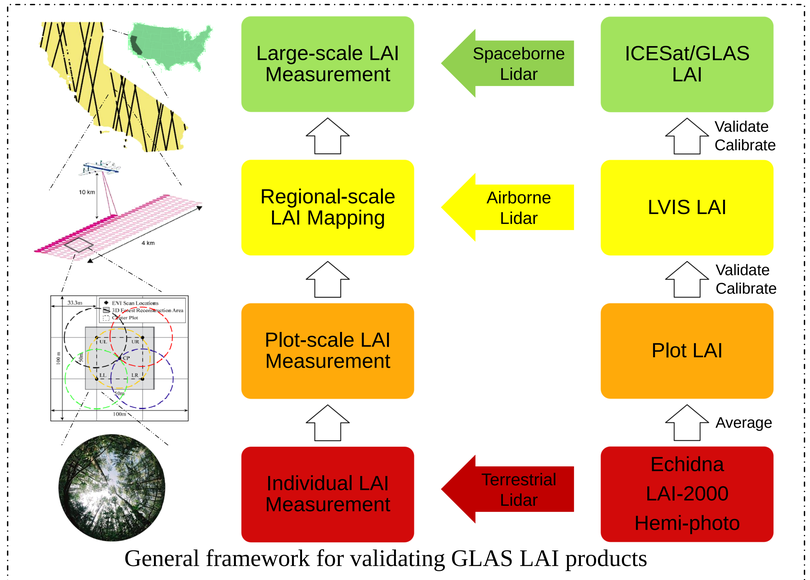
Framework



Methods

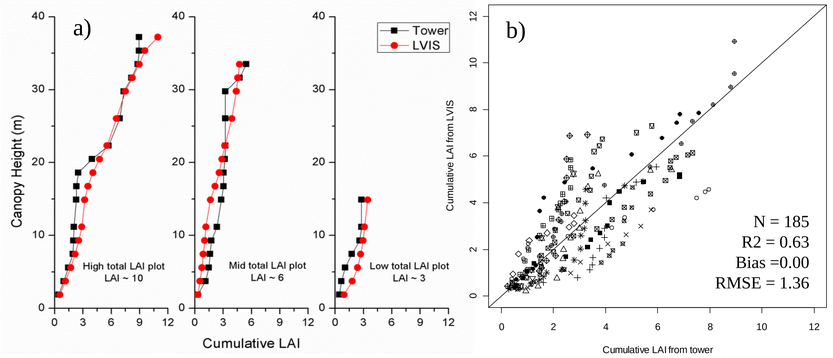


Derive LAI from lidar waveform using a GORT model

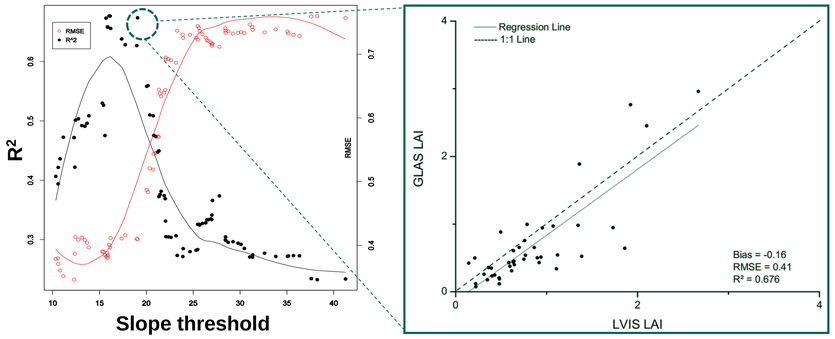


General framework for validating GLAS LAI products

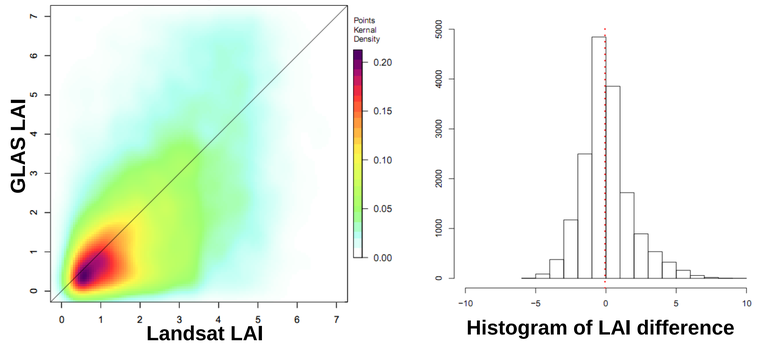
Results



a) **Examples of cumulative LAI profiles from destructive sampling and derived from LVIS.**
b) **Cumulative LAI estimated from LVIS against cumulative LAI for towers with a distance less than 5 m from the laser pointing center.**



RMSE and R2 calculated upon comparison of all LVIS LAI and GLAS LAI values as a function of slope threshold (x). For a given slope α, the y-axis represents the RMSE (or r2) of GLAS shots with slope < α.



Comparison between GLAS LAI and Landsat LAI over the entire state of California

Implications

The potential LAI products resulting from this study will be used to provide the first significant attempt to obtain large-scale estimates of LAI from lidar remote sensing. Such products will improve current climate and ecological models through more accurate parameterization.

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